

WHAT IS CLAIMED AS NEW AND DESIRED TO BE SECURED BY LETTERS
PATENT OF THE UNITED STATES IS:

1. A pressure swing adsorption (PSA) system comprising:
 - a first group of PSA modules including a plurality of first PSA modules,
 - a second group of PSA modules including a plurality of second PSA modules,
 - a feed gas manifold connected to said first PSA modules and said second PSA modules;
 - a product manifold connected to said first PSA modules and said second PSA modules;
 - a waste manifold connected to said first PSA modules and said second PSA modules,
 - wherein each first PSA module operates on a first PSA cycle in synchronization with the other first PSA modules,
 - wherein each second PSA module operates on a second PSA cycle in synchronization with the other second PSA modules, and
 - wherein said first PSA cycle is offset from said second PSA cycle.
2. The PSA system according to Claim 1, wherein said first PSA cycle is one hundred and eighty degrees out of phase from said second PSA cycle.
3. The PSA system according to Claim 1, further comprising a third group of PSA modules including a plurality of third PSA modules, and a fourth group of PSA modules including a plurality of fourth PSA modules, wherein:
 - said feed gas manifold is connected to said third PSA modules and said fourth PSA modules;
 - said product manifold is connected to said third PSA modules and said fourth PSA modules;

said waste manifold is connected to said third PSA modules and said fourth PSA modules;

each third PSA module operates on a third PSA cycle in synchronization with the other third PSA modules;

each fourth PSA module operates on a fourth PSA cycle in synchronization with the other fourth PSA modules; and

wherein said first PSA cycle, said second PSA cycle, said third PSA cycle, and said fourth PSA cycle are offset from one another.

4. The PSA system according to Claim 3, wherein said first PSA cycle, said second PSA cycle, said third PSA cycle, and said fourth PSA cycle are each operated at ninety degrees out of phase.

5. The PSA system according to Claim 1, wherein said first group of PSA modules includes four PSA modules, and wherein said second group of PSA modules includes four PSA modules.

6. The PSA system according to Claim 1, wherein each of said first PSA modules include seven adsorbent chambers operated utilizing three pressure equalizations during said first PSA cycle.

7. The PSA system according to Claim 1, wherein said first group of PSA modules includes a first predetermined number of first PSA modules and said second group of PSA modules includes a second predetermined number of second PSA modules, and wherein said first predetermined number equals said second predetermined number.

8. The PSA system according to Claim 1, further comprising:
a product surge tank connected to said product manifold; and
a waste surge tank connected to said waste manifold.

9. The PSA system according to Claim 1, wherein said first PSA modules each comprise a plurality of PSA adsorbent chambers.

10. The PSA system according to Claim 1, wherein each first PSA module includes a first predetermined number of first PSA adsorbent chambers and each second PSA module includes a second predetermined number of second PSA adsorbent chambers, and wherein said first predetermined number equals said second predetermined number.

11. The PSA system according to Claim 1, wherein said plurality of first PSA modules and said plurality of second PSA modules each comprise:

- a plurality of pressurized adsorbent chambers;

- an inlet manifold provided with a feed channel connected to said feed manifold and each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers, said inlet manifold being provided with a waste channel connected to said waste manifold and each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers;

- an outlet manifold provided with a product channel connected to said product manifold and each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers; and

- a rigid structure connecting said inlet manifold to said outlet manifold,

- wherein said rigid structure structurally joins said inlet manifold and said outlet manifold to said plurality of pressurized adsorbent chambers.

12. A pressure swing adsorption (PSA) module for use in a PSA system, said PSA module comprising:

- a plurality of pressurized adsorbent chambers;

- an inlet manifold provided with a feed channel connected to each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers, said inlet manifold

being provided with a waste channel connected to each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers;

an outlet manifold provided with a product channel connected to each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers; and

a rigid structure connecting said inlet manifold to said outlet manifold,

wherein said rigid structure structurally joins said inlet manifold and said outlet manifold to said plurality of pressurized adsorbent chambers.

13. The PSA module according to Claim 12, wherein said rigid structure is not in contact with fluid flowing through said PSA module.

14. The PSA module according to Claim 12, wherein said rigid structure includes a plurality of tie bolts extending between said inlet manifold and said outlet manifold.

15. The PSA module according to Claim 12, wherein said rigid structure includes a plurality of panels extending between said inlet manifold and said outlet manifold.

16. The PSA module according to Claim 15, further comprising a cover enclosing said outlet manifold and a plurality of valves provided on said outlet manifold.

17. The PSA module according to Claim 12, wherein each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers includes a first sealing boss provided between said pressurized fluid chamber and said inlet manifold and a second sealing boss provided between said pressurized fluid chamber and said outlet manifold.

18. The PSA module according to Claim 17, wherein at least one pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers comprises:

a retainer plate provided at one end of and extending across a flow path of said at least one pressurized adsorbent chamber;

a mesh layer provided adjacent to said retainer plate and extending across said flow

path of said at least one pressurized adsorbent chamber; and

an adsorbent mass provided adjacent to said mesh layer,

wherein said first sealing boss has a portion that extends within said pressurized adsorbent chamber, said portion having a concave surface provided opposite said retainer plate, said concave surface and said retainer plate defining a chamber, and

wherein said first sealing boss includes a flow distributor provided within said chamber.

19. The PSA module according to Claim 12, wherein at least one pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers comprises:

a first retainer plate provided at one end of and extending across a flow path of said at least one pressurized adsorbent chamber;

a first mesh layer provided adjacent to said first retainer plate and extending across said flow path of said at least one pressurized adsorbent chamber;

a second retainer plate provided at an opposite end of and extending across said flow path of said at least one pressurized adsorbent chamber;

a second mesh layer provided adjacent to said second retainer plate and extending across said flow path of said at least one pressurized adsorbent chamber; and

an adsorbent mass provided between said first mesh layer and said second mesh layer.

20. The PSA module according to Claim 19, wherein said at least one pressurized adsorbent chamber further comprises an elastic layer provided between said first retainer plate and said adsorbent mass, wherein said elastic layer is held in compression between said first retainer plate and said adsorbent mass.

21. The PSA module according to Claim 20, wherein said elastic layer is a filter.

22. The PSA module according to Claim 19, wherein said at least one pressurized

adsorbent chamber further comprises a first radial seal ring configured to join together said first retainer plate and said first mesh layer and a second radial seal ring configured to join together said second retainer plate and said second mesh layer.

23. The PSA module according to Claim 19, wherein said at least one pressurized adsorbent chamber further comprises a first snap ring configured to mount said first retainer plate and said first mesh layer and a second snap ring configured to mount said second retainer plate and said second mesh layer.

24. The PSA module according to Claim 12, wherein said outlet manifold is provided with a first equalization channel connected to each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers, and wherein said outlet manifold is provided with a second equalization channel connected to each pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers.

25. The PSA module according to Claim 12, wherein said rigid structure is connected to at least one pressurized adsorbent chamber of said plurality of pressurized adsorbent chambers by means for connecting that does not transmit a bending moment to said at least one adsorbent chamber.